

since in  $B$  the expression  $\frac{e_m(\theta_w)}{p}$  is very much less than unity, this is practically identical with (9a).

From equation (9) the following numerical relation between the equivalent potential temperature  $\theta_e$  and the wet-bulb temperature  $\theta_w$  is found:

$\theta_e$	260°	270°	280°	290°	300°	310°	320°	330°	340°	350°
$\theta_w$	257.2	264.6	271.3	276.8	281.7	285.9	289.4	292.5	295.3	297.8

The relation is represented graphically in figure 2.

Thus the use of  $\theta_e$  or  $\theta_w$  to identify a mass of moist air undergoing pseudoadiabatic changes is a matter of personal choice. The wet-bulb potential temperature appears

to have a certain conceptual advantage since it does not require the air to be taken to zero pressure for extraction of its precipitable water. Moreover, the wet-bulb potential temperature is closely related to the wet bulb temperature, a quantity which can be easily measured.

## REFERENCES

- (1) F. Linke, *Met. Zeit.* 55, 345-350 (1938).
- (2) C.-G. Rossby, *M. I. T. Met. Papers*, Vol. 1, No. 3 (1932).
- (3) D. Brunt, *Physical and Dynamical Meteorology*, Cambridge, p. 406 (1934).
- (4) *l. c.* (2) equation 26, page 10.
- (5) *l. c.* (3) equation 11, page 54.
- (6) Normand, *Mem. Indian Met. Dept.*, No. 23 (1921).
- (7) *l. c.* (3), equations 38, 39, page 82.

## TROPICAL DISTURBANCES OF SEPTEMBER 1940

By J. H. GALLENNÉ

[Weather Bureau, Washington, Nov. 2, 1940]

*August 30-September 3.*—The first indications of probable origin of this hurricane appeared on the morning of August 30, as a mild depression central about 225 miles off the Florida east coast. A slow progressive movement toward the north-northwest with rapid development, was indicated by the report of an unidentified vessel near 32°12' N., and 72°24' W., at 5 p. m. of that day, which recorded an east-southeast wind, force 10, with barometer reading of 978.7 millibars (28.90 inches). During the next day the disturbance was attended by severe squalls and strong shifting gales over a large area and by winds of hurricane strength near its center. Shortly after the morning observation of September 1, the course of the disturbance seems to have changed from north-northwest to north-northeast.

The American S. S. *Dungannon* reported that she encountered north-northeast winds, force 10, at 8 a. m. of September 1, near 35°50' N., and 73°45' W., with pressure reading 993 millibars (29.32 inches), and that the wind shifted to northwest and increased to force 12 shortly thereafter. During the evening of the same day, the tanker *Franklin K. Lane*, on a voyage from New York to Corpus Christi, reported that she met an east-southeast hurricane which shifted to west-northwest near 38°17' N., and 70°32' W. She also reported that a pressure reading of 965.1 millibars (28.50 inches) was noted during the passage of the hurricane. This is the lowest barometer reading of record in connection with the disturbance. Several other vessels reported winds of force 8 or higher, on the 1st. (See Table of Ocean Gales and Storms on page 255 in this REVIEW.)

The disturbance was centered at 7:30 a. m., September 2, about 75 miles east-northeast of Nantucket, Mass., moving rapidly north-northeastward. The Weather Bureau office, Nantucket, Mass., recorded a maximum velocity, for a 5-minute period, of 57 miles an hour, from the northeast and an extreme velocity of 65 miles an hour on September 2. This exceeds all previous September wind records at that station.

The storm moved inland a short distance to the northwest of Yarmouth, Nova Scotia, with rapidly diminishing intensity, during the evening of the 2d, and apparently dissipated in the region north of Anticosti Island, Quebec, on September 3.

Timely warnings and advisories were issued from the

forecast center at Washington, D. C., covering the movement of this hurricane.

*September 11-18.*—On the 7:30 a. m. chart of September 11, 1940, there were some indications of a disturbance of slight intensity about 250 miles northeast of St. Thomas, V. I., moving in a west-northwesterly direction. During that afternoon, an unidentified vessel near latitude 20° N., and longitude 64°30' W., reported cloudy weather, northwest wind, force 6, with a barometric pressure reading 1,007 millibars (29.74 inches).

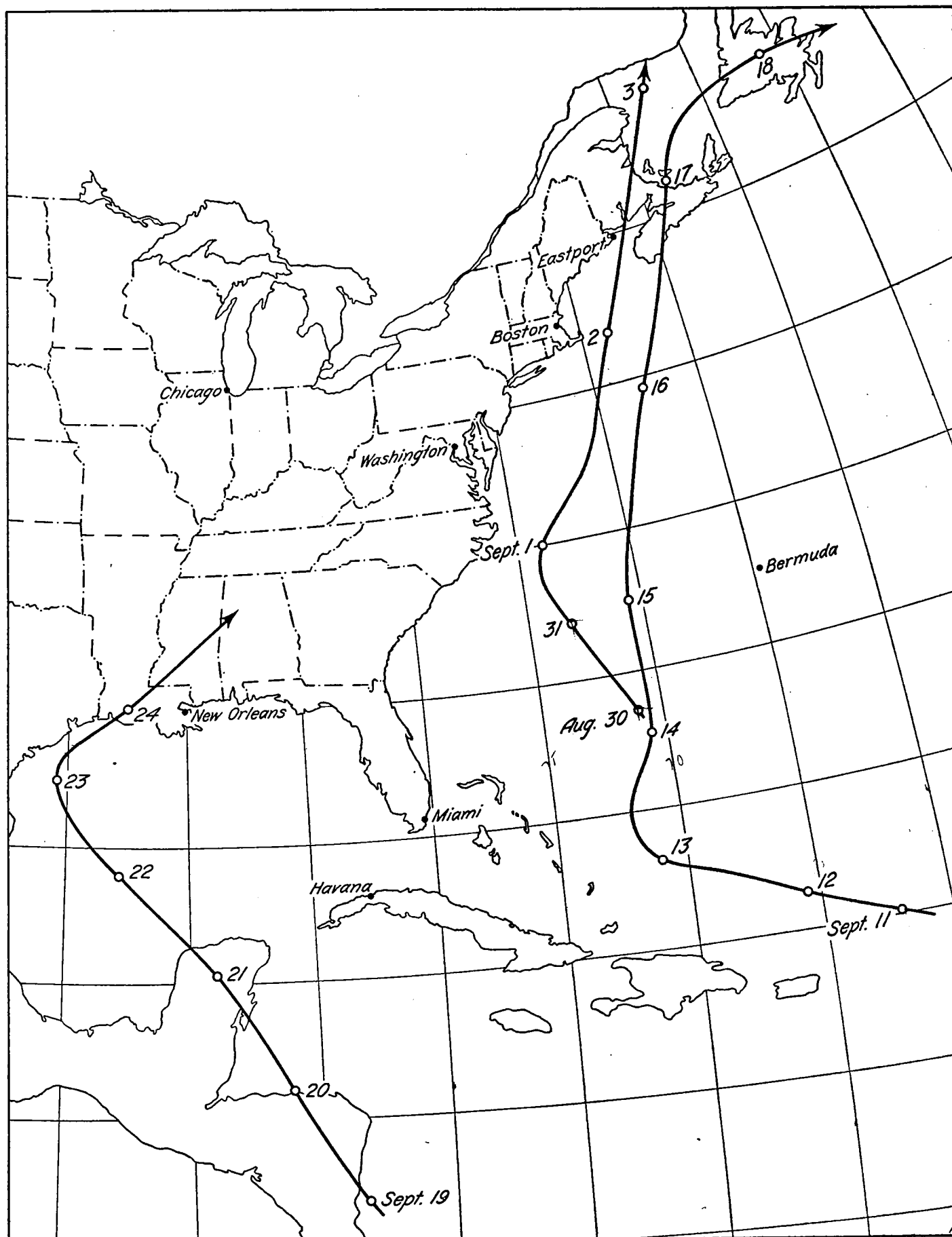
The depression developed very rapidly during the 12th, causing moderate gales over a large area to the right of its path. At 7:30 p. m. the center was near 22°30' N., and 68° W., from which point it continued to move in a west-northwesterly direction until the following morning. During the 13th it curved to the north and northeast attended by strong gales and continued falling pressure.

At the morning observation of September 14 the storm was central about 475 miles east-northeast of Nassau, moving at a rate of about 12 to 14 miles an hour. An observation from the S. S. *Borinquen* indicated that the disturbance developed to full hurricane strength during that day. The vessel met a north-northeast wind, force 12, at 5 p. m., near latitude 30°24' N., and longitude 71° W., with barometer reading 988.3 millibars (29.19 inches). Her daily journal from local noon to midnight of September 14 reads: "Overcast, heavy rain, ship hove to; vessel laboring and shipping water." The S. S. *Coamo* also became involved in the hurricane on the 14th, reporting that she encountered an east-northeast wind, force 11, at 11 p. m., near 30°14' N., and 72° W.

For the next 48 hours the storm moved rapidly in a north-by-east direction and was centered near 39°30' N., and 68° W., at 7:30 a. m. of September 16, attended by moderate to heavy rain, in the vicinity of Nantucket, Mass., and by gales over a very wide ocean area.

Scattered ship reports indicate that thick weather, with rough seas, and heavy rain squalls were associated with the disturbance as it moved inland during the evening of September 18, a short distance north of Cape Race, Newfoundland.

Although this storm developed full hurricane force, no reports have been received of loss of life or property damage, probably due to the fact that it remained well at sea during practically its entire passage.



Tracks of tropical disturbances in September 1940.

The movements of this hurricane were amply covered by advisories and warnings issued by the Weather Bureau.

*September 19-24.*—A rather weak tropical disturbance, 1,006 millibars (29.71 inches), formed on the morning of September 19, 1940, in the vicinity of Bluefields, Nicaragua. It progressed in a northwestward direction over the Gulf of Honduras during the next 24 hours and moved inland over Quintana Roo during the night of September 20. By the afternoon of September 21 the depression had entered the Gulf of Mexico, northwest of Progreso, Yucatan, attended by winds of force 4-5 (Beaufort Scale).

The disturbance continued to move northwestward increasing slowly in intensity after passing into the Gulf of Mexico. On the morning of September 23, it was centered near latitude  $27^{\circ}45'$  N., and longitude  $95^{\circ}30'$  W. An unidentified vessel in the western portion of the Gulf of Mexico at 5 a. m. of the 23d, encountered a fresh gale from the northwest. That afternoon, the depression moved very slowly and curved rather sharply to the northeast. The tanker *Dannedaike* met a fresh south-

west gale near  $28^{\circ}$  N., and  $95^{\circ}$  W., at 7 p. m. of the 23d, with the lowest pressure reading of the storm, 1,004 millibars (29.65 inches).

During the early morning of September 24 the disturbance passed inland over southwestern Louisiana, a short distance to the west of Lafayette. Heavy rains were associated with this storm over southern Louisiana and along the upper coast to Texas, the heaviest amount reported being 7.10 inches at Cheneyville, La.

The depression, decreasing in intensity after passing inland, continued to move northeastward and merged with a low-pressure trough which dominated the south-central and eastern portions of the United States, during the evening of September 24.

Advisories and warnings were issued by the forecast center at New Orleans, La., from September 21, when the disturbance entered the Gulf of Mexico, until it moved inland and diminished rapidly on the 24th.

A diagram showing the tracks of these disturbances appears herewith.

## METEOROLOGICAL AND CLIMATOLOGICAL DATA FOR SEPTEMBER 1940

[Climate and Crop Weather Division, J. B. KINCEP in charge]

### AEROLOGICAL OBSERVATIONS

By EARL C. THOM

The mean surface temperatures during September (chart I) were above normal over the western and north-central parts of the United States, and but slightly below normal over most of the rest of the country. A considerable area in the north central and extreme north portions of the country averaged  $6^{\circ}$  F., or more, above normal with the maximum positive departure of about  $8^{\circ}$  F. occurring in scattered areas of Montana and northeastern Wyoming. In three small widely scattered areas of the east and south temperatures for the month were  $4^{\circ}$  F. below normal.

At the 1,500 m. level the direction of the 5 a. m. resultant wind for the month (chart VIII) was north of the corresponding normal resultant (clockwise turning) over all of the eastern half of the country and at San Diego with the opposite departure from normal direction over the rest of the country. At the 3,000 m. level (chart IX) the same general departure of the 5 a. m. resultant direction from normal was noted except that the counter clockwise turning from normal was also noted at Houston and at Key West. At 5,000 meters the 5 p. m. resultant direction (chart X) when compared to the 5 a. m. normals at that level show southward turning from normal in the area west of a line from Duluth to El Paso, while all stations east of this line, except Arlington, show resultants more northerly than normal.

The 5 a. m. resultant velocities for the month were above the corresponding normal in the southwest and extreme west parts of the country at the 1,500 m. level and were generally below normal over the rest of the country. The resultant velocities were about 3 m. per second above normal along the California coast and averaged about 3 m. per second below normal over the northern Great Lakes and the extreme north central region. At the 3,000 m. level the 5 a. m. resultant velocities were below normal over most of the northern half of the country and were generally above normal to the southward. At the 5,000 m. level the September 5 p. m. resultant velocities were considerably above the corresponding 5 a. m. normals over most of the country.

Reference to chart I indicates that the mean temperatures in the area west of a line drawn across the United

States through St. Louis, Mo., and Abilene, Tex., were above normal for September while temperatures in the rest of the country were below normal. This division of the country corresponds closely to the corresponding northward and southward departures from normal of the resultant directions for the month at the 1,500 m., 3,000 m., and 5,000 m. levels.

In September the directions of the 5 p. m. resultant winds at 1,500 meters were north of the corresponding 5 a. m. resultants at this level over the northwest and the Rocky Mountain region while, except at two stations, the resultant winds turned to the southward during the day over the rest of the country. At the 3,000 m. level the resultant winds turned to the northward during the day over the western one-third of the country and turned to the southward over the central one-third while the shifts were well distributed at this level over the Eastern States.

At the 1,500 m. level the resultant velocities at 5 p. m. for the month were higher than the corresponding 5 a. m. velocities over about half of the country, including New England, the extreme Northern States, the Southwest and and most of the South Central and Gulf Coast States. At 3,000 m. the change in resultant velocities from 5 a. m. to 5 p. m. were again well distributed, the velocities in the evening being higher than the morning velocities over the New England States, over Florida, and over most of the central and west central region.

The upper air wind data discussed above are based on 5 a. m. observations (charts VIII and IX) as well as on observations made at 5 p. m. (table 2, charts X and XI).

At all 1,000 m. levels from 4,000 m. up to 18,000 m. above sea level the highest pressures observed over the country (table I) occurred on or near the southwest boundary line of the United States, the maximum pressure at each of these levels being recorded at one or more of the three stations Brownsville, El Paso, or Phoenix. The lowest pressure over the United States at each 1,000 m. level from 4,000 m. to 17,000 m., occurred at Sault Ste. Marie. At 3,000 m. the same minimum pressure (707 mb.) occurred at Sault Ste. Marie as at several other stations, while at 18,000 m. a low pressure reading of 78